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UNITED STATES
COAST AND GEODETIC SURVEY
T. C. MENDENHALL
SUPERINTENDENT

HYPSOMETRY

HEIGHTS FROM GEODETIC LEVELING

BETWEEN

CORINTH, MISS., AND MEMPHIS, TENN.

1890–1891

Report by CHARLES A. SCHOTT, Assistant
and Chief of the Computing Division

Field work by ISAAC WINSTON, Sub-Assistant
and F. A. YOUNG, Aid

APPENDIX No. 4—REPORT FOR 1892

WASHINGTON
GOVERNMENT PRINTING OFFICE
1893

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APPENDIX NO. 4—1892.

ON THE RESULTS OF SPIRIT LEVELING OF PRECISION BETWEEN CORINTH, MISS., AND MEMPHIS, TENN., FROM OBSERVATIONS MADE IN 1890 AND 1891 BY ISAAC WINSTON, SUBASSISTANT, AND F. A. YOUNG, AID.

A report by CHARLES A. SCHOTT, Assistant and Chief of the Computing Division.
Submitted for publication March 10, 1893.

The following report on the results of spirit leveling between Corinth, Miss., and Memphis, Tenn., is herewith respectfully submitted. Corinth is a station in the line of levels from Mobile to Odin, and Memphis is connected with the levels of the Mississippi River from New Orleans to St. Louis; the present line therefore forms a tie between these lines.

Route line.—The levels follow the track of the Memphis and Charleston Railroad. Distance between bench mark V at Corinth and bench mark of U. S. E. at Memphis is 151·3 km., or 94·0 statute miles. See illustration (inset) to the preceding appendix (No. 3 for 1892).

Observers and dates.—The observers were Subassistant I. Winston and Mr. F. A. Young. The work was accomplished between November 7, 1890, and January 23, 1891.

Instruments and methods of observing.—Two independent lines were run, one forward (westerly), the other backward (easterly). Mr. Winston ran the forward line from Corinth to La Grange, Tenn., and the backward line from Memphis to La Grange, using level No. 5. Mr. Young ran the backward line from La Grange to Corinth, and the forward line from La Grange to Memphis, using level No. 6. Metric rods N and O were employed.

Instrumental constants.—These are as follows:

Instrument.	No. 5.	No. 6.
Aperture of telescope,	2·9$^{\rm cm}$.	2·9$^{\rm cm}$.
Focal length of telescope,	34·8$^{\rm cm}$.	34·8$^{\rm cm}$.
Magnifying power,	28	28
Value of one division of striding level,	2″·11 and 2″·08	2″·44 and 2″·62
Mean adopted,	2″·10	2″·53
When determined (E. G. F. and I. W., observers),	Sept. 26, '88, Apr. 8, '90	May 23, '88, Apr. 8, '90
Inequality of collars { + larger, indicates object end. — smaller, }	—0″·48 Mar. 15, '90 —0″·89 Feb. 13, '91	+0″·07 Mar. 15, 90 —0″·01 Feb. 9, 13, '91

Weighted mean, the second value having double weight,	—0″·76	+0″·02
Value of 100 divisions (1 turn) of micrometer screw,	313″·1 and 311″·6	310″·6 and 312″·0
Value adopted,	312″·0	312″·0
When determined (A. B., I. W. and J. H. G., observers),	Sept. 19, 22, '88, July 22, 23, '89	June 24, 25, '89, July 22, 23, '89
Angular value of telemeter threads,	18′ 58″·5	18′ 50″·6
When determined (I. W., observers),	July 22, 1889	July 22, 1889

Index corrections to metric rods:	N at beginning,	—0·55$^{\text{mm}}$.	at 12° C.	Mar. 14, 1890
	N at end,	—0.35		Feb. 1891
	O at beginning,	—0·63	at 13° C.	Mar. 14, 1890
	O at end,	—0·40		Feb. 1891

Temperature when rod graduations are of standard length, 21·°7 C.

Computation and results.—The field computation was made by the observers; the office computation by Subassistant J. Nelson, temporarily attached to the Computing Division. The two computations were collated, and the results are given in the following tabular form:

Results of geodetic spirit leveling in Mississippi and Tennessee, 1890–'91, from Corinth, Miss., to Memphis, Tenn.

Date.		Bench mark		Distance		Difference of height between marks.			Discrepancy.		Height of mark above average Gulf level at Biloxi, Miss.
						Direction of measure			Partial.	Total.	
		From—	To—	Between successive marks.	From initial mark.	Forward (westerly).	Backward (easterly).	Mean.	F—B	Accumulated.	
1890–'91.				*km.*	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
Jan.			V		0·000					0·0	+137·2281*
31	31	V	W	0·041		+ 0·0568	+ 0·0567				
Dec. 20	Dec. 20			0·040		+ 0·0567	+ 0·0566				
Mean				0·040	0·040	+ 0·0568	+ 0·0566	+ 0·0567	+0·2	+ 0·2	+137·2848*
20	26	W	70	0·343	0·383	— 4·4635	— 4·4613	— 4·4624	—2·2	— 2·0	132·8224
20	26	70	71	1·106	1·489	+ 3·9480	+ 3·9471	+ 3·9476	+0·9	— 1·1	136·7700
20	26	71	72	0·962	2·451	+ 2·4790	+ 2·4738	+ 2·4764	+5·2	+ 4·1	139·2464
22	24	72	73	0·990	3·441	+ 4·8421	+ 4·8404	+ 4·8412	+1·7	+ 5·8	144·0876
22	24	73	74	0·966	4·407	+ 8·6416	+ 8·6413	+ 8·6414	+0·3	+ 6·1	152·7290
22	23	74	75	1·280	5·687	—10·9292	-------				
24	24			1·283		—10·9368	—10·9313				
Mean		74	75	1·281	5·688	—10·9330	—10·9313	—10·9322	—1·7	+ 4·4	141·7968
22		75	× Road (1)	0·328		— 1·2119					140·5849
22	23	75	76	1·153	6·841	— 5·9312	— 5·9339	— 5·9325	+2·7	+ 7·1	135·8643
22	23	76	77	1·170		+ 9·1223	+ 9·1130				
26	26			1·168		+ 9·1183	+ 9·1173				
Mean		76	77	1·169	8·010	+ 9·1203	+ 9·1152	+ 9·1177	+5·1	+12·2	144·9820
22		77	× Road (2)	1·026		+ 4·7340					+149·7160

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* See report of December 20, 1892. (App. No. 3, Report for 1892.)

Results of geodetic spirit leveling in Mississippi and Tennessee, 1890–'91, from Corinth, Miss., to Memphis, Tenn.

Date.		Bench mark		Distance		Difference of height between marks.			Discrepancy.		Height of mark above average Gulf level at Biloxi, Miss.
						Direction of measure.			Partial.	Total.	
		From—	To—	Between successive marks.	From initial mark.	Forward (westerly).	Backward (easterly).	Mean.	F–B	Accumulated.	
1890–'91. Jan.				*km.*	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
22	23	77	78	1·276	9·286	+ 4·5100	+ 4·5053	+ 4·5076	+4·7	+16·9	+149·4896
22	23	78	79	0·702	9·988	— 2·0810	— 2·0831	— 2·0820	+2·1	+19·0	147·4076
26	23	79	80	1·016	11·004	— 9·7686	— 9·7667	— 9·7677	—1·9	+17·1	137·6399
26, 27	30	80	81	0·984	11·988	— 5·7740	— 5·7723	— 5·7731	—1·7	+15·4	131·8668
27	30	81	82	0·960	12·948	— 0·5979	— 0·5999	— 0·5989	+2·0	+17·4	131·2679
27	30	82	83	0·986	13·934	— 5·0828	— 5·0847	— 5·0837	+1·9	+19·3	126·1842
27	30	83	84	1·294	15·228	— 2·1891	— 2·1854	— 2·1872	—3·7	+15·6	123·9970
27		84	× Road (3)	0·170		+ 0·3128					124·3098
30	30	84	L	0·092	15·320	+ 1·5460	+ 15·461	+ 1·5460	+0·1	+15·7	125·5430
27	30	84	85	1·234	16·462	— 2·4519	— 2·4465	— 2·4492	—5·4	+10·2	121·5478
27	30, 31	85	86	1·234	17·696	— 1·8310	— 1·8284	— 1·8297	—2·6	+ 7·6	119.7181
27	31	86	87	0·948	18·644	— 1·6550	— 1·6568	— 1·6559	+1·8	+ 9·4	118·0622
27	31	87	88	0·967	19·611	— 1·2996	— 1·2976	— 1·2986	—2·0	+ 7·4	116·7636
Jan. 2	Dec. 31	88	M	1·307	20·918	+ 0·0220	+ 0·0216	+ 0·0218	+0·4	+ 7·8	116·7854
2	31	M	89	1·225	22·143	— 0·0419	— 0·0390	— 0·0404	—2·9	+ 4·9	+116·7450
2	29, 31	89	90	1·037		+10·0377					
2	Jan. 2			1·039		+10·0383	+10·0415				
2				1·039		+10·0405	+10·0401				

		Mean	89	90	1·038	23.181	+10·0388	+10·0408	+10.0398	−2·0	+ 2·9	+126·7848
Jan. 2, 3		Dec. 29	90	91	0·971		− 5·9608	− 5·9692				
	3				0·965		− 5·9590	− 5·9566				
		Mean	90	91	0·968	24·149	− 5·9599	− 5·9629	− 5·9614	+3·0	+ 5·9	120·8234
3		29	91	92	1·248	25·397	− 5·7634	− 5·7646	− 5·7640	+1·2	+ 7·1	115·0594
3		29	92	93	1·055	26·452	− 0·8390	− 0·8377	− 0·8384	−1·3	+ 5·8	114·2210
3		29	93	94	1·196	27·648	+ 0·9230	+ 0·9193	+ 0·9211	+3·7	+ 9·5	115·1421
3	Jan.	12	94	95	0·949	28·597	+ 0·4307	+ 0·4283	+ 0·4295	+1·4	+10·9	115·5716
3		12	95	96	1·105	29·702	− 0·9869	− 0·9823	− 0·9846	−4·6	+ 6·3	114·5870
3		12	96	97	0·858	30·560	+ 5·1725	+ 5·1741	+ 5·1733	−1·6	+ 4·7	119·7603
	5		97	N	0·073	30·633	+ 1·9079	+ 1·9082	+ 1·9080	−0·3	+ 4·4	121·6683
	5		N	R. R. S. (4)	0·075		− 1·6330		− 1·6330			120·0353
5		10	97	98	1·241		+ 6·9543	+ 6·9634				
	12				1·244		+ 6·9562	+ 6·9529				
		Mean	97	98	1·242	31·802	+ 6·9552	+ 6·9582	+ 6·9567	−3·0	+ 1·7	126·71707
Jan. 5		Jan. 10	98	99	1·351	33·153	−11·5391	−11·5355	−11·5373	−3·6	− 1·9	115·1797
5		10	99	100	1·264		+ 0·7862	+ 0·7960				
13		13			1·259		+ 0·7927	+ 0·7924				
		Mean	99	100	1·262	34·415	+ 0·7894	+ 0·7942	+ 0·7918	−4·8	− 6·7	115·9715
5		10	100	101	1·298	35·713	+ 6·4514	+ 6·4550	+ 6·4532	−3·6	−10·3	122·4247
5		10	101	102	0·998		− 5·3672	− 5·3611				
	13				0·996		− 5·3607	− 5·3601				
		Mean	101	102	0·997	36·710	− 5·3639	− 5·3606	− 5·3622	−3·3	−13·6	117·0625
5		10	102	103	1·180	37·890	+ 2·7697	+ 2·7745	+ 2·7721	−4·8	−18·4	+119·8346

Results of geodetic spirit leveling in Mississippi and Tennessee, 1890–'91, from Corinth, Miss., to Memphis, Tenn.

Date.		Bench mark		Distance		Difference of height between marks.			Discrepancy.		Height of mark above average Gulf level at Biloxi, Miss.
						Direction of measure.			Partial.	Total.	
		From—	To—	Between successive marks.	From initial mark.	Forward (westerly).	Backward (easterly).	Mean.	F-B	Accumulated.	
1890–'91. Jan. 6				*km.*	*km.*	*m.*	*m.*	*m.*	*mm*	*mm.*	*m.*
		103	R. R. S. (5)	0·937		+ 4·1489		+ 4·1489			+123·9835
Jan. 6	Jan. 9	103	104	1·030	38·920	+ 3·6806	+ 3·6836	+ 3·6821	—3·0	—21·4	123·5167
8		104	O	0·091	39·011	+ 1·3123	+ 1·3126	+ 1·3124	—0·3	—21·7	124·8291
6	8	104	105	0·980	39·900	+ 8·4975	+ 8·4967	+ 8·4971	+0·8	—20·6	132·0138
6	8	105	106	1·267	41·167	+ 2·6365	+ 2·6394	+ 2·6380	—2·9	—23·5	134·6518
6	7, 8	106	107	1·282	42·449	— 5·6788	— 5·6782	— 5·6785	—0·6	—24·1	128·9733
6	7	107	108	1·322	43·771	+ 5·7190	+ 5·7247	+ 5·7218	—5·7	—29·8	134·6951
6	7	108	109	0·996		+ 7·1268	+ 7·1353				
13				0·992		+ 7·1206	+ 7·1266				
	Mean.	108	109	0·994	44·765	+ 7·1237	+ 7·1310	+ 7·1274	—7·3	—37·1	141·8225
6	7	109	110	0·994		— 2·8901	— 2·8811				
13				0·992		— 2·8894	— 2·8870				
	Mean.	109	110	0·993	45·758	— 2·8898	— 2 8840	— 2·8869	—5·8	—42·9	138·9356
6 and 14	7	110	111	1·126	46·884	+ 4·4670	+ 4·4685	+ 4·4678	—1·5	—44·4	143·4034
14		111	x Road (6)	0·183		+ 0·5318		+ 0·5318			+143·9352
14	7	111	112	1·081		+ 8·7684	+ 8·7749				
19				1·085		+ 8·7726	+ 8·7634				

		Mean.	111	112	1·083	47·967	+ 8·7705	+ 8·7692	+ 8·7698	+1·3	—43·1	+152·1732
14		19	112	113	0·944	48·911	+ 8·1018	+ 8·1038	+ 8·1028	—2·0	—45·1	160·2760
14		19	113	114	1·280	50·191	— 3·7915	— 3·7942	— 3·7928	+2·7	—42·4	156·4832
14		19	114	115	1·278	51·469	— 2·0418	— 2·0382	— 2·0400	—3·6	—46·0	154·4432
14		17, 19	115	116	0·932	51·401	+ 0·2744	+ 0·2767	+ 0·2756	—2·3	—48·3	154·7188
14		17	116	117	0·978	53·379	+ 9·0213	+ 9·0191	+ 9·0202	+2·2	+46·1	163·7390
14, 15		17	117	118	1·043	54·422	+ 9·1038	+ 9·1009	+ 9·1023	+2·9	—43·2	172·8413
15		17	118	119	1·142		— 9·3487	— 9·3558				
	20				1·140		— 9·3582	— 9·3602				
		Mean.	118	119	1·141	55·563	— 9·3534	— 9·3580	— 9·3557	+4·6	—38·6	163·4856
15		17	119	120	1·048	56·611	— 9·0299	— 9·0239	— 9·0269	—6·0	—44·6	154·4587
	15		120	R. R. S. (7)	0·953		+ 8·2111		+ 8·2111			162·6698
15		17	120	121	1·026	57·637	+ 9·2172	+ 9·2175	+ 9·2173	—0·3	—44·9	163·6760
	20		121	P	0·378	58·015	+ 1·3896	+ 1·3889	+ 1·3892	+0·7	—44·2	165·0652
15		16, 17	121	122	0·997	58·634	+ 9·3888	+ 9·3881	+ 9·3884	+0·7	—44·2	173·0644
15		16	122	123	0·963	59·597	+ 6·8406	+ 6·8456	+ 6·8431	—5·0	—49·2	179·9075
20		16	123	124	0·874		+ 0·0069	+ 0·0027				
	23				0·863		+ 0·0024	+ 0·0041				
		Mean.	123	124	0·868	60·465	+ 0·0046	+ 0·0034	+ 0·0040	+1·2	—48·0	179·9115
20		16	124	125	1·032	61·497	— 0·5980	— 0·5956	— 0·5968	—2·4	—50·4	179·3147
	20		125	x Road (8)	0·233		+ 0·4664		+ 0·4664			179·7811
20		16	125	126	1·224	62·721	— 4·4270	— 4·4252	— 4·4261	—1·8	—52·2	174·8886
20		16	126	127	1·007		— 9·4517	— 9·4398				
	22				1·011		— 9·4435	— 9·4454				
		Mean.	126	127	1·009	63·730	— 9·4476	— 9·4426	— 9·4451	—5·0	—57·2	+165·4435

Results of geodetic spirit leveling in Mississippi and Tennessee, 1890–'91, from Corinth, Miss., to Memphis, Tenn.

Date.			Bench mark		Distance		Difference of height between marks.			Discrepancy.		Height of mark above average Gulf level at Biloxi, Miss.
							Direction of measure			Partial.	Total.	
			From—	To—	Between successive marks.	From initial mark.	Forward (westerly).	Backward (easterly).	Mean.	F-B	Accumulated.	
	1890–'91.											
Jan.	Jan.	Jan.			*km.*	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
20		16	127	128	1·060	64·790	+ 6·5350	+ 6·5320	+ 6·5335	+3·0	—54·2	+171·9770
20, 21		22	128	129	0·993	65·783	+ 0·3981	+ 0.3973	+ 0·3977	+0·8	—53·4	172·3747
21		22	129	130	0·732	66·515	+ 2·4904	+ 2·4859	+ 2·4882	+4·5	—48·9	174·8629
	21		130	R	0·033	66·548	+ 2·0967	+ 2·0967	+ 2·0967	0·0	—48·9	176·9596
	21		130	R. R. x (9)	0·159	66·674	— 0·0149		— 0·0149			174·8480
21		22	130	131	1·112	67·627	— 3·4512	— 3·4437				
	23				1·116		— 3·4449	— 3·4383				
		Mean	130	131	1·114	67·629	— 3·4480	— 3·4410	— 3·4445	—7·0	—55·9	171·4184
21		22	131	132	1·090	68·719	+ 9·9455	+ 9·9434	+ 9·9444	+2·1	—53·8	181·3628
21		22	132	133	1·040	69·759	— 8·6040	— 8·6036	— 8·6038	—0·4	—54·2	172·7590
21		22	133	134	0·950	70·709	— 6·5675	— 6·5639	— 6·5657	—3·6	—57·8	166·1933
	Dec.											
21		19	134	I	1·002	71·711	— 4·0401	— 4·0368	— 4·0384	—3·3	—61·1	162·1549
19		19	I	K	0·052	71·763	+ 0·0321	+ 0·0321	— 0·0321	0·0	—61·1	162·1870
16		16	I	69	0·538	72·249	— 0·1246	— 0·1275	— 0·1260	+2·9	—58·2	162·0289
	16		69	68	1·016	73·265	— 6·9467	— 6·9461	— 6·9464	—0·6	—58·8	155·0825
17		16	68	67	0·978	74·243	+ 1·3614	+ 1·3600	— 1·3607	+1·4	—57·4	156·4432
17		16	67	66	0·996	75·239	— 4·1521	— 4·1533	+ 4·1527	+1·2	—56·2	152·2905
17		16	66	65	1·004	76·243	+ 1·0775	+ 1·0781	+ 1·0778	—0·6	—56·8	+153·3683
17		15, 16	65	64	0·998		— 4·3609	— 4·3685				

	19				1·000		— 4·3554	— 4·3619				
	19				0·998		— 4·3614					
		Mean	65	64	0·998	77·241	— 4·3592	— 4·3652	— 4·3622	+6·0	—50·8	+149·0061
17		15	64	63	1·008	78·249	+ 0·3464	— 0·3450	— 0·3457	—1·4	—52·2	148·6604
17		15	63	62	1·253	79·502	— 2·4429	— 2·4422	— 2·4426	—0·7	—52·9	146·2178
17, 18		15	62	61	1·259	80·761	— 7·2864	— 7·2900	— 7·2882	+3·6	—49·3	138·9296
	15		61	x Road (10)	0·176		+ 0·8151		+ 0·8151			139·7447
18		15	61	60	1·188	81·949	— 8·1255	— 8·1244	— 8·1250	—1·1	—50·4	130·8046
18		15	60	59	1·176	83·125	—10·0920	—10·0933	—10·0926	+1·3	—49·1	120·7120
Dec.		Dec.										
18		15	59	58	1·060	84·185	— 8·0044	— 7·9979	— 8·0012	—6·5	— 55·6	112·7108
18		15	58	57	1·126	85·311	— 5·1168	— 5·1107	— 5·1138	—6·1	— 61·7	107·5970
18		13	57	56	0·956	86·267	+ 1·7642	+ 1·7658	+ 1·7650	+1·6	— 63·3	109·3620
18		13	56	H	1·168	87·435	— 1·9477	+ 1·9445	— 1·9461	—3·2	— 66·5	107·4159
	5		H	G	1·190	88·625	— 4·8566	— 4·8593	— 4·8580	+2·7	— 63·8	102·5579
	5		G	55	0·454	89·079	+ 0·2748	+ 0·2724	— 0·2736	+2·4	— 61·4	102·8315
6		5	55	54	0·979	90·058	— 1·9955	— 1·9948	— 1·9952	—0·7	— 62·1	100·8363
6		4, 5	54	53	1·055	91·113	+ 0·1366	+ 0·1355	+ 0·1360	+1·1	— 61·0	100·9723
6		4	53	52	1·115		+ 2·9207	+ 2·9269				
	8				1·108		+ 2·9255	+ 2·9245				
		Mean	53	52	1·112	92·225	+ 2·9231	+ 2·9257	+ 2·9244	—2·6	— 63·6	103·8967
6		4	52	51	1·249		— 1·8694	— 1·8615				
	8				1·253		— 1·8687	— 1·8676				
		Mean	52	51	1·251	93·476	1·8690	— 1·8646	— 1·8668	—4·4	— 68·0	102·0299
	4		51	R.R.S.(11)	0·338		1·4186		+ 1·4186			103·4485
8		4	51	50	1·286		— 2·3477	— 2·3381				
	8				1·291		— 2·3458	— 2·3457				
		Mean	51	50	1·288	94·764	— 2·3468	— 2·3418	— 2·3443	—5·0	— 73·0	+99·6856

Results of geodetic spirit leveling in Mississippi and Tennessee, 1890–'91, from Corinth, Miss., to Memphis, Tenn.

Date.			Bench mark		Distance		Difference of height between marks.			Discrepancy.		Height of mark above average Gulf level at Biloxi, Miss.
							Direction of measure.			Partial.	Total.	
			From—	To—	Between successive marks.	From initial mark.	Forward (westerly).	Backward (easterly).	Mean.	F–B	Accumulated.	
1890–'91.					*km.*	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
Dec.	Dec.	Dec.										
6, 9		4	50	49	0·919	95·683	— 1·6297	— 1·6262	— 1·6280	—3·5	— 76·5	+98·0576
9		4	49	48	0·972		— 1·3892	— 1·3805				
	12				0·972		— 1·3907	— 1·3865				
	13				0·972		— 1·3869	— 1·3838				
		Mean	49	48	0·972	96·655	— 1·3889	— 1·3836	— 1·3862	—5·3	— 81·8	96·6714
9		4	48	47	1·043	97·698	— 0·4312	— 0·4275	— 0·4294	—3·7	— 85·5	96·2420
9		4	47	46	1·134		— 1·8048	— 1·7987				
	12				1·138		— 1·8012	— 1·7953				
	13				1·134		— 1·8035	— 1·7999				
		Mean	47	46	1·135	98·833	— 1·8032	— 1·7980	— 1·8006	—5·2	— 90·7	94·4414
9		4	46	45	1·228	100·061	— 0·1258	— 0·1253	— 0·1256	—0·5	— 91·2	94·3158
	3		45	F	0·252	100·313	+ 0·6906	+ 0·6905	+ 0·6906	+0·1	— 91·1	94·0064
9		3	45	44	1·387	101·448	— 0·4077	— 0·4117	— 0·4097	+4·0	— 87·2	93·9061
	3		44	R.R.S.(12)	1·068		+ 1·0321		+ 1·0321			+94·9382
9, 10		3	44	43	1·286		+ 0·0129	+ 0·0213				
	12				1·286		+ 0·0188	+ 0·0208				

		Mean	44	43	1·286	102·734	+ 0·0158	+ 0·0210	+ 0·0184	—5·2	— 92·4	+93·9245
10		3	43	42	1·276	104·010	— 0·6659	— 0·6641	— 0·6650	—1·8	— 94·2	93·2595
10		3	42	41	1·302	105·312	+ 5·4004	+ 5·4020	+ 5·4012	—1·6	— 95·8	98·6607
10		3	41	40	1·061	106·373	+ 3·9880	+ 3·9869	+ 3·9874	+1·1	— 94·7	102·6481
10		3	40	39	1·140	107·513	+ 6·7072	+ 6·7048	+ 6·7060	+2·4	— 92·3	109·3541
10		2, 3	39	38	1·038	108·551	— 3·7185	— 3·7205	— 3·7195	+2·0	— 90·3	105·6346
	2		38	X Road(13)	0·161		+ 0·3593		+ 0·3593			105·9939
10, 11		2	38	37	1·000	109·551	— 4·0632	— 4·0624	— 4·0628	—0·8	— 91.1	101·5718
11		Nov. 17	37	36	1·144	110·695	+ 4·7456	+ 4·7440	+ 4·7448	+1·6	— 89·5	106·3166
11		17	36	35	0·952	111·647	+ 7·7233	+ 7·7242	+ 7·7238	—0·9	— 90·4	114·0404
	Nov. 15		35	E	0·060	111·707	+ 3·3665	+ 3·3665	+ 3·3665	0·0	— 90·4	117·4069
Nov. 15		17	35	34	0·978	112·625	— 3·5693	— 3·5712	— 3·5702	+1·9	— 88·5	110·4702
	17		34	R.R.S.(14)	0·866		+ 3·7767		+ 3·7767			114·2469
15		17	34	33	0·982	113·607	— 3·0443	— 3·0459	— 3·0451	+1·6	— 86·9	107·4251
21		17	33	32	1·148	114·755	+ 0·2086	+ 0·2056	+ 0·2071	+3·0	— 83·9	107·6322
22		21	32	31	1·518		— 4·7011	— 4·7124				
	Dec. 2				1·512		— 4·6967	— 4·7077				
	11				1·524		— 4·7095	— 4·7055				
		Mean	32	31	1·518	116·273	— 4·7024	— 4·7085	— 4·7054	+6·1	— 77·8	102·9268
Nov. 22		Nov. 21	31	30	1·252		+ 3·3520	+ 3·3572				
	Dec. 2				1·258		+ 3·3553	+ 3·3571				
		Mean	31	30	1·255	117·528	+ 3·3536	+ 3·3572	+ 3·3554	—3·6	— 81·4	+106·2822

Results of geodetic spirit leveling in Mississippi and Tennessee, 1890–'91, from Corinth, Miss., to Memphis, Tenn.

Date.		Bench mark		Distance		Difference of height between marks.			Discrepancy.		Height of mark above average Gulf level at Biloxi, Miss.
		From—	To—	Between successive marks.	From initial mark.	Direction of measure.		Mean.	Partial.	Total.	
						Forward (westerly).	Backward (easterly).		F–B	Accumulated.	
				km.	*km.*	*m.*	*m.*	*m.*	*mm.*	*mm.*	*m.*
1890–'91. Nov. 22		30	D	0·089	117·617	+ 2·1867	+ 2·1866	+ 2·1866	+0·1	— 81·3	+108·4688
Nov. 22	Nov. 21	30	29	0·557	118·085	+ 1·0289	+1·0297	+ 1·0293	—0·8	— 82·2	107·3115
21		29	R.R.S.(15)	0·511		— 0·6646		— 0·6646			106·6469
22	21	29	28	1·259	119·344	+ 2·9755	+ 2·9783	+ 2·9769	—2·8	— 85·0	110·2884
22	21	28	27	0·934	120·278	+ 1·5384	+ 1·5360	+ 1·5372	+2·4	— 82·6	111·8256
22	21	27	26	0·955	121·233	— 2·3511	— 2·3508	— 2·3510	—0·3	— 82·9	109·4746
21		26	X Road(16)	0·371		+ 1·0476		+ 1·0476			110·5222
24	20	26	25	0·924	122·157	— 0·2714	— 0·2689	— 0·2702	—2·5	— 85·4	109·2044
24	20	25	24	0·942	123·099	— 1·4447	— 1·4447	— 1·4447	0·0	— 85·4	107·7597
24	20	24	23	1·236	124·335	+ 4·8628	+ 4·8668	+ 4·8648	—4·0	— 89·4	112·6245
24	20	23	22	1·231	125·566	+ 4·0760	+ 4·0791	+ 4·0776	—3·1	— 92·5	116·7021
24	20	22	C	1·233	126·799	— 1·6107	— 1·6151	— 1·6129	+4·4	— 88·1	115·0892
20		C	R.R.S.(17)	0·204		— 0·5511		— 0·5511			114·5381
24	20	C	21	0·500	127·299	— 4·4361	+ 4·4358	— 4·4360	—0·3	— 88·4	110·6532
24, 25	20	21	20	1·288	128·587	— 5·7824	— 5·7814	— 5·7819	—1·0	— 89·4	104·8713
25	19	20	19	0·937	129·524	— 3·7895	— 3·7870	— 3·7882	—2·5	— 91·9	+101·0831
25	19	19	18	1·038		+ 0·5208	+ 0·5325				

	Dec. 1				1·034		+ 0·5265	+ 0·5226				
		Mean	19	18	1·036	130·560	+ 0·5236	+ 0·5276	+ 0·5256	−4·6	− 95·9	+101·6087
Nov. 25		Nov. 19	18	17	1·324	131·884	− 2·2307	− 2·2261	− 2·2284	−4·6	−100·5	99·3803
25		19	17	16	1·253		+ 3·9835	+ 3·9900				
	Dec. 1				1·248		+ 3·9930	+ 3·9948				
		Mean	17	16	1·250	133·134	+ 3·9882	+ 3·9924	+ 3·9903	−4·2	−104·7	103·3706
Nov. 25, 26		Nov. 19	16	15	1·240	134·374	− 2·5543	− 2·5497	− 2·5520	−4·6	−109·3	100·8186
26		19	15	B	0·958		− 5·4651	− 5·4595				
	29				0·959		− 5·4634	− 5·4640				
		Mean	15	B	0·958	135·332	− 5·4642	− 5·4618	− 5·4630	−2·4	−111·7	95·3556
26		19	B	14	1·276		+ 1·5580	+ 1·5641				
	29				1·280		+ 1·5613	+ 1·5624				
		Mean	B	14	1·278	136·610	+ 1·5596	+ 1·5632	+ 1·5614	−3·6	−115·3	96·9170
26		18	14	13	1·034		− 7·5718	− 7·5847				
29		28			1·038		− 7·5814					
Dec. 1		29			1·036		− 7·5798	− 7·5834				
	Dec. 1				1·033			− 7·5818				
		Mean	14	13	1·035	137·645	− 7·5777	− 7·5833	− 7·5805	+5·6	−109·7	89·3365
Nov. 26		Nov. 18	13	12	1·139		− 1·2852	− 1·2926				
	28				1·141		− 1·2882	− 1·2882				
		Mean	13	12	1·140	138·785	− 1·2867	− 1·2904	− 1·2886	+3·7	−106·0	+ 88·0479

Results of geodetic spirit leveling in Mississippi and Tennessee, 1890–'91, from Corinth, Miss., to Memphis, Tenn.

Date.			Bench mark.		Distance		Difference of height between marks.			Discrepancy.		Height of mark above average Gulf level at Biloxi, Miss.
							Direction of measure			Partial.	Total,	
			From—	To—	Between successive marks.	From initial mark.	Forward (westerly).	Backward (easterly).	Mean.	F–B	Accumulated.	
1890–'91.					km.	km.	m.	m.	m.	mm.	mm.	m.
Nov.	Dec.	Nov.										
26		18	12	11	1·200	139·985	+ 3·7370	+ 3·7324	+ 3·7347	+4·6	—101·4	+91·7826
	18		11	x Road (18)	0·158		— 0·0278		— 0·0278			91·7548
11, 26		18	11	10	1·188	141·173	— 2·0136	— 2·0128	— 2·0132	—0·8	—102·2	89·7694
	18		10	A	0·076	141·249	+ 1·3684	+ 1·3683	+ 1·3684	+0·1	—102·1	91·1378
11		10	10	9	0·856	142·029	— 1·7642	— 1·7608	— 1·7625	—3·4	—105·6	88·0069
11		10	9	8	1·693		+ 2·8728	+ 2·8638				
14		18			1·698		+ 2·8747	+ 2·8771				
		Mean	9	8	1·696	143·725	+ 2·8738	+ 2·8704	+ 2·8721	+3·4	+102·2	90·8790
11		10	8	7	1·112		— 2·5017	— 2·5031				
	14				1·118		— 2·4979	— 2·5054				
	28				1·114		— 2·5054	— 2·5062				
		Mean	8	7	1·115	144·840	— 2·5017	— 2·5049	— 2·5033	+3·2	— 99·0	88·3757
11, 12		10	7	6	1·184	146·024	+ 5·6152	+ 5·6143	+ 5·6148	+0·9	— 98·1	93·9905
	10		6	x Road (19)	1·080		— 5·5554		— 5·5554			88·4351
12		10	6	5	1·052	147·076	+ 1·2252	+ 1·2258	+ 1·2255	—0·6	— 98·7	95·2160
12		8	5	4	1·290	148·366	— 8·0234	— 8·0251	— 8·0242	+1·7	— 97·0	+87·1918

12		8	4	3	1·277		—10·2550	—10·2416				
	13				1·280			—10·2547				
13		13, 14			1·279		—10·2573	—10·2590				
		Mean	4	3	1·279	149·645	—10·2562	—10·2518	—10·2540	—4·4	—101·4	+76·9378
12, 13	7	8	3 1	1 U. S. E.	1·677 0·038	151·322 151·360	+ 5·2234 — 2·1142	+ 5·2215 — 2·1142	+ 5·2224 — 2·1142	+1·9 0·0	— 99·5 — 99·5	82·1602 +80·0460

262.62
8.13
270.75

M.R.C.=271.25

The probable error of the resulting differences of heights depends on the discrepancies of the results as found by the forward and backward measures, and since the bench marks are about evenly distributed over the whole line at distances of about one kilometre we make use of the formula $r_{11} = 0{\cdot}675 \sqrt{\frac{[d\,d]}{4\,[s]}}$, which gives the probable error per kilometre for double leveling; for the terminal point at the distance $S = [s]$ we have $r = 0{\cdot}675 \sqrt{\frac{[d\,d]}{4}}$.

We have $[dd] = 1466$, hence $r_{11} = \pm 1{\cdot}05^{\text{mm.}}$, also $r = \pm 12{\cdot}9^{\text{mm.}}$ The column showing the accumulation of error exhibits the usual more or less systematic increase over the whole line, with a maximum value of 115^{mm}; this corresponds to an angle of $0''{\cdot}16$, or to a constant error of $0''{\cdot}08$ for each measure, supposed of the same sign.

Referring to my report of December 20, 1892 (Appendix No. 3, 1892), and to the closing of the two loops, II and III, we have now for $\triangle h$ Memphis to Corinth $+57{\cdot}1821^{\text{m.}}$ in the place of the rough result (57·2160) given there, and the closing of the triangular figure Corinth, Cairo, Memphis, Corinth, becomes $-0{\cdot}2424^{\text{m}}$, and that of the larger southern loop, Biloxi, Mobile, Corinth, Memphis, Vicksburg, New Orleans, Biloxi, $-0{\cdot}2732^{\text{m.}}$. The development in length of the first loop is $747.3^{\text{km.}}$ and of the second $1832{\cdot}4^{\text{km.}}$. A description of the bench marks concludes this report.

Description of bench marks on line of levels from Corinth, Miss., to Memphis, Tenn., 1890–'91.

V.—Corinth, Alcorn County, Miss. A brass bolt leaded in the east wall of the brick store on the northwest corner of Waldren and ——— streets. This building is opposite the court-house, and is used as the city hall. The bolt is in the third course of brick above the sill of the windows near the north end of the building and in the fourth brick south of this window. Two lines were cut in the end of the bolt, forming a + at its center, and the intersection of these lines is the B. M. The building is owned by Eli Mitchell.

W.—Corinth, Alcorn County, Miss. A brass bolt leaded in the west wall of the brick court-house. The bolt is between the fifth and sixth ventilators (small grated windows) to the cellar, counting from the northwest corner of the building, in the fifth brick south of fifth ventilator and in the fourteenth course below line of window sills. Two lines were cut in the end of the bolt, forming a cross at its center, and the intersection of these lines is the B. M.

L.—Chewalla, McNairy County, Tenn. A copper bolt leaded in the side face of brick chimney on east end of frame house occupied by F. S. McCallar, railroad agent, at Chewalla. The bolt is in the fourteenth course above the ground and in the second brick from the end of the house, and in the side of the chimney towards the front of the house. The house is north of the track and east of the public road. Two lines were cut in the end of the bolt, forming a cross (+) at its center, and the intersection of these lines is the B. M.

M.—Cypress Creek, railroad bridge, Tenn. A square hole cut in the top of the stone pier of the iron railroad bridge over Cypress Creek. It is on the pier on the east bank of the creek and is south of the track outside of the superstructure of the bridge near the outer edge of the pier. The letters U. S. B. M. were roughly cut near it. The bottom of the square hole is the B. M.

N.—Pocahontas, Tenn. A copper bolt leaded in the front face of the "Brick Hotel." The bolt is in the twelfth course above the ground and in the third brick from the southwest corner of the building. The hotel is north of the track and nearly opposite the railroad station. It is kept by Mr. Seay, the railroad agent. Two lines were cut in the end of the bolt, forming a cross (+) at its center, and the intersection of these lines is the B. M.

O.—Middleton, Hardeman County, Tenn. A copper bolt leaded in the face of the west side wall to the brick store just west of the hotel. The building faces the railroad and is quite near it. The bolt is in the fourth course below the front door sill and in the second brick from the northwest corner of the building. Two lines were cut in the end of the bolt, forming a cross (+) at its center, and the intersection of these lines is the B. M.

P.—Saulsbury, Hardeman County, Tenn. A copper bolt leaded in the face of the west side wall to the brick store owned and occupied by R. M. Wright. The bolt is near the southwest corner, in the twenty-first course above the ground, and in the fifth brick from the southwest corner. Two lines were cut in the end of the bolt, forming a cross, and the intersection of these lines is the B. M.

R.—Grand Junction, Tenn. A copper bolt leaded into the face of the front wall to the brick store owned and occupied by W. R. Robinson. The store is north of the track and a short distance east of the railroad crossing. The bolt is near the southeast corner of the building, in the fourth course above the front porch, and in the second brick from the southeast corner. Two lines were cut in the end of the bolt, forming a cross, and the intersection of these lines is the B. M.

I.—La Grange, Fayette County, Tenn. A square hole cut in the top of the stone abutment to the railroad bridge over Main street. The abutment is on the east side of the street and is north of the track. The bottom of the hole is the B. M.

K.—La Grange, Fayette County, Tenn. A square hole cut in the top of the stone abutment to the railroad bridge over Main street.

The abutment is on the west side of the street, and is south of the track. The bottom of the hole is the B. M.

H.—Moscow, Fayette County, Tenn. A cavity was cut in the rough face of one of the stones in the foundation of the railroad water tank, and a square hole made in the bottom of this cavity for the B. M. This cavity is on the south face (next to the track) of the foundation, and 6·2 feet from the southwest corner. The bottom of the square hole is the B. M.

G.—Wolf River railroad bridge. A square hole was cut in the top of the stone pier to the iron railroad bridge over Wolf Creek. It is on the pier on the east bank of the creek, on the inner side of the raised portion on the north end of the pier, and 1·5 feet from its eastern face. It was roughly lettered U. S. □ B. M. The bottom of the hole is the B. M.

F.—Rossville, Fayette County, Tenn. A square hole about one-fourth inch deep, cut in the top of a ledge in the stone foundation of the railroad water tank. The hole is only a few inches above the ground, and is 2 feet north of the southeast corner of the foundation, and is on the east side of the tank. The bottom of the square hole is the B. M.

E.—Colliersville, Shelby County, Tenn. A copper bolt (five-eighths inch in diameter) leaded in the front of Duloney & Patrick's brick storehouse, which faces the public square and is on the east side, a short distance from the railroad. The bolt is in the eleventh course above the ground and in the third brick from the southwest corner of the building. Two lines were cut in the end of the bolt, forming a cross (+), and the intersection of these lines is the B. M.

D.—Bailey's Station, Shelby County, Tenn. A copper bolt (five-eighths inch in diameter) leaded in the brick chimney on the west end of J. W. Brown's residence. The bolt is in the corner brick on the south or front face of the chimney and in the twenty-second course above the ground. Two lines were cut in the end of the bolt, forming a cross, and the intersection of these lines is the B. M.

C.—Germantown, Shelby County, Tenn. A square hole, about one-fourth inch deep, cut in the northwest corner of the upper surface of the stone cap to the brick pier, under the northwest corner of the platform to the railroad station. The bottom of the square hole is the B. M.

B.—White's Station, Shelby County, Tenn. A square hole cut in the stone foundation to the railroad water tank. It is on the top of the offset, at the southwest corner of the tank, about 18 inches above the ground, and is marked as follows: U. S. ▬ B. M., the letters being rudely cut in the limestone. The bottom of the square hole is the B. M.

A.—Buntyn, Shelby County, Tenn. This B. M. is the upper surface of the first brick offset above the ground on the west side of the entrance to the Methodist church. Three lines were cut in the brick, forming a square with the outer edge, and the bench mark is the upper surface of the brick within this square. It is on the third brick from the west side of entrance. This church is a substantial brick building.

U. S. P. B. M. "Memphis."—Memphis, Tenn. Is the center of a hole in head of copper bolt leaded horizontally in face of subsill of first basement window from southwest corner, on west side of new custom-house. It is marked U. S.
⊙ . This bench was established
B. M.
in 1878 (see Rep. of Miss. River Comm. for 1881, pp. 65, 66). When visited in November, 1890, this bench mark was found undisturbed and in good condition.

Crossroad No. 1.—Ground at center of track, at public road crossing, 3½ miles west of Corinth, Miss.

Crossroad No. 2.—Ground at center of track at public road crossing at Wenasoga.

Crossroad No. 3.—Ground at center of track at public road crossing at Cheewalla, Tenn.

Railroad station No. 4.—Ground at center of track opposite railroad station at Pocahontas.

Railroad station No. 5.—Ground at center of track opposite railroad station at Middletown.

Crossroad No. 6.—Ground at center of track, public road crossing at 64-mile post.

Railroad station No. 7.—Ground at center of track opposite railroad station at Saulsbury, Tenn.

Crossroad No. 8.—Ground at center of track at public road crossing 2½ miles west of Saulsbury, Tenn.

Crossroad No. 9.—Ground at center of track at crossing of Illinois Central Railroad, Grand Junction, Tenn.

Crossroad No. 10.—Ground at center of track at public road crossing 4 miles east of Moscow, Tenn.

Railroad station No. 11.—Ground at center of track opposite old railroad warehouse at Hays' Crossing.

Railroad station No. 12.—Ground at center of track opposite railroad station at Rossville.

Crossroad No. 13.—Ground at center of track, State line road crossing, 2½ miles east of Colliersville, Tenn.

1 Railroad crossing, station No. 15.—Ground at center of track opposite railroad station at Bailey's.

Crossroad No. 16.—Ground at center of track at public road crossing at Forest Hill.

Railroad station No. 17.—Ground at center of track opposite railroad station at Germantown.

Crossroad No. 18.—Ground at center of track at Grier's road crossing.

Crossroad No. 19.—Ground at center of track at Pigeon Roost road crossing.

[1] Railroad crossing, station No. 14.—Ground at center of track opposite railroad station at Colliersville, Tenn.